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BY C. F. ADAMS.

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BY CLEM A. COPELAND.

FINAL REPORT ON COLUMBIA RIVER POWER PROJECT.
BY BOARD OF REVIEW.

STANDARDS FOR ELECTRIC SERVICE.
BY U. S. BUREAU OF STANDARDS.

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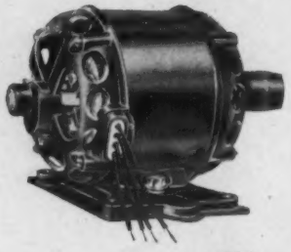

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Willow Creek Pumping Station.

PUMPING PLANTS FOR RICE IRRIGATION

BY C. F. ADAMS.

Along the west side of the upper Sacramento River there is developing a new industry which promises to provide a power load that will use the total capacity of the present electric service in this district. This is the industry of rice growing. The "rice-belt" covers an area which is estimated at from 70,000 to 80,000 acres, and the average power consumption will be about 150 h.p. per thousand acres.

The topography of this country is interesting, being the result of the surface wash from the western mountain slopes, combined with the silt deposited from the areas that are naturally flooded by the Sacramento River. The wash from the hills has created a plain, 15 to 20 miles in width, having a slope of three to ten feet to the mile toward the river. The great annual flood of the river has tended to raise the river bed and also its banks by sedimentary deposits. This action of the river has built up a strip of land about three miles in width on either side of the river, which slopes back with a grade of three feet to the mile.

The point where the river slope meets the western hill slope is known as the "Trough," and it constitutes a natural over-flow and flood channel parallel to the river course.

The pioneer rice development in the "Trough" is operated by the Rice Land & Products Company, who have 6000 acres under cultivation. In planning their irrigation system, the canals were so located as to use both the waters of the Sacramento River and the drainage waters in the "Trough."

Pumping plant No. 1, known as the "River plant," is located on the Compton ranch about four miles from Princeton and nine miles from Colusa. The river at this point has a maximum variation in depth of about 26 ft. The pumps and motors, which are direct connected, are located in a concrete pit protected by the river levee, and about ten feet below the normal ground level. During high water period there is a static head of about eight feet on these pumps. The discharge pipe valves can be opened so as to fill the canals without pumping.

During the pumping season the actual water lift varies from six to eighteen feet. This water is discharged into a concrete forebay and then flows through the main canal straight west for a distance of 3.3 miles crossing the channel of Willow Creek at grade. A small overflow wier arrests the waters of Willow Creek and the second pumping plant handles the total flow of both streams. About five hundred acres are irrigated from the main canal before it reaches Willow Creek.

Pumping plant No. 2, known as the Willow Creek plant, lifts the water seven feet to a new canal level. This canal, which has a base width of sixteen feet and

Thrashing the Rice Harvest.

Suction Pipes at Willow Creek in Course of Construction.

a depth of four feet six inches, continues west two miles, to pumping plant No. 3, where a similar lift is made. The main canal is located along the northern line of the rice fields and the laterals are carried south a distance of three and one-half miles.

The equipment of the pumping plants is as follows:

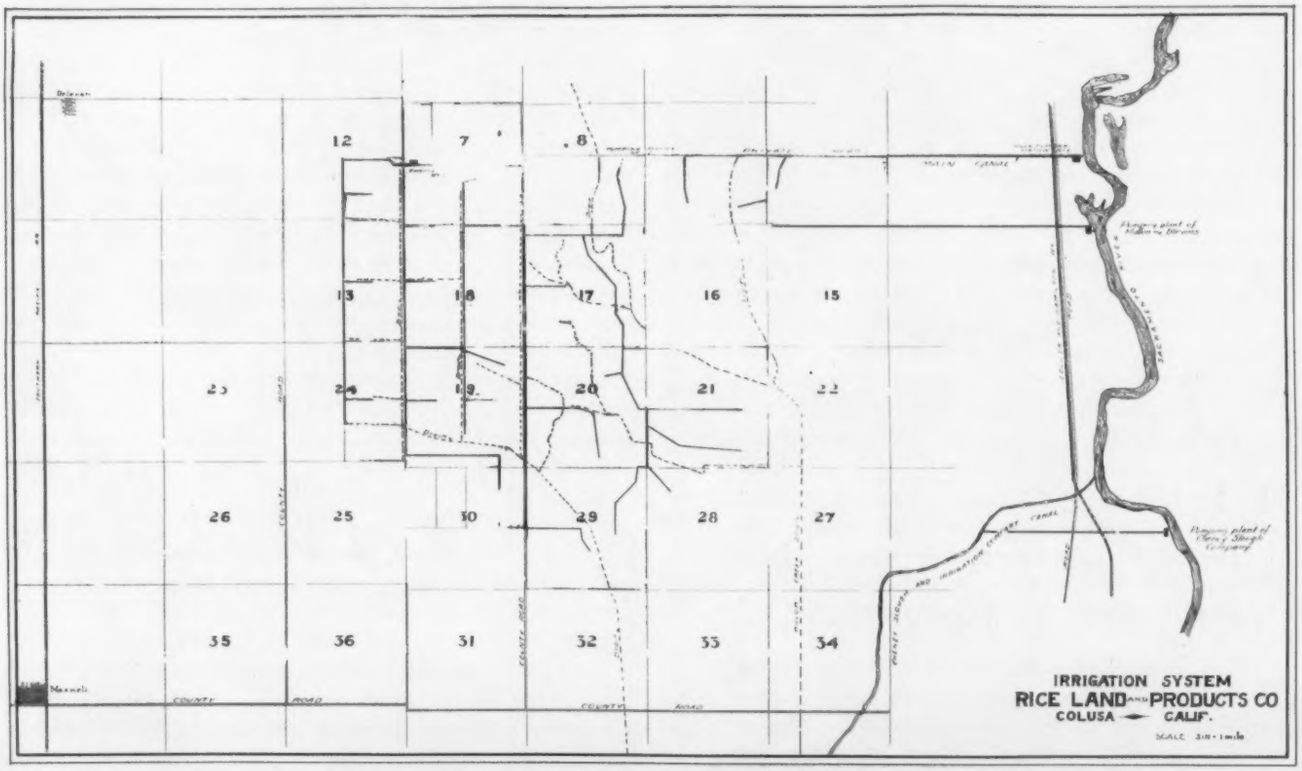
Plant No. 1.

Pumps.	Motors.
1916—2-24 in. Worthington.	2-150 h.p. Westinghouse.
1917—1-36 in. Worthington .	1-250 h.p. Westinghouse.
Plant No. 2.	
1916—2-24 in. Worthington.	2- 75 h.p. Westinghouse.
1917—1-35 in. Worthington.	1-150 h.p. Westinghouse.
Plant No. 3.	
1916—1-36 in. Byron Jackson.	1-100 h.p. Westinghouse.

In plants No. 1 and No. 2 a Worthington wet vacuum priming pump is used and in Plant No. 3 a Baker Hanson priming unit is employed.

The electric power is procured from the transmission lines of the Northern California Power Company Consolidated. Their main substation is located along the Princton road. Two banks of transformers are installed. One bank, 60,000/2200, operates the River Plant and the plant of Mallon and Blevins, half a mile away, which supplies water to 1300 acres. A second bank, 60,000/6600, conveys current to pumping plants No. 2 and No. 3, a total distance of six miles. The total load estimated for this outdoor substation, known as "Rice," is 1100 h.p.

The pumping season lasts from April 15th to September 15th, and during this period the load is practically constant. The maximum use of water is during the month of May, at which time the land is being flooded and drained at intervals until the plant growth permits the continuous flooding of the ground. The amount of water required per acre for rice in variable, depending on the nature of the soil and also on the methods of the grower. Under the conditions of good soil and careful irrigation, five feet per year may be used, but a use of seven acre feet is not abnormal, and even eighteen acre feet has been used on porous soils. It is obvious that the costs of pumping will largely determine what areas can profitably grow rice. For the average installation a power rate of one cent per kw.-hr. is being given.



General Map of Rice Fields of Northern California.

The average plant efficiency of irrigation plants may be assumed at 60 per cent on the higher class installations, falling as low as 40 per cent where cheap first cost alone is considered. For rice irrigation, where the monthly power cost may reach $1500, the owner is justified in a critical examination of all plant details —pump efficiency, pipe losses, water velocity losses, etc. If his ditches pass through sections of porous soil, a concrete lining of the ditch may mean a big saving in operation. The permissible water velocity in canals is an item of importance, and one that varies

Unloading a Pump from a Barge on the Sacramento River.

largely with different soils. For the average "sediment adobe" soil of the rice belt, a ditch grade of three feet per mile will be satisfactory. Where sharper grades are necessary erosion will result unless protection is used.

For the average rice plantation, having its own pumping plants, ditches, etc., the total water cost per acre may be assumed as $4.80, where the average water lift is not over 20 ft., and the water is obtained from a stream such as the Sacramento.

The problem of water supply for the rice industry will be the subject of much future discussion, and its solution will be probably found in large reservoir construction, as well as the construction of drainage canals which may reach the magnitude of water transportation canals, and these may convey the rice products to tide water.

ELECTRIC FURNACES AT SALT LAKE CITY.

The Utah Iron & Steel Company, Salt Lake City, Utah, is considering the installation of electric furnaces chiefly for converting the scrap material available in that district into soft steel which may be rolled in its mills at Middale, near Salt Lake City. It is considering also the possibility of utilizing local ores for the manufacture of ferrotungsten and ferrochrome. It may install a furnace of as large as 12 or 15 tons' capacity, and perhaps two of the furnaces. The interests controlling the Utah Iron & Steel Company, also own the American Foundry & Machine Company, Salt Lake City, which is expanding its foundry business, and in that connection is shortly to install a 3-ton Rennerfelt electric furnace. Low-cost electricity and an abundance of scrap material make the electric furnace an attractive proposition against local high cost of suitable coke and high-cost pig iron.

NAVIGABILITY OF COLUMBIA AND SNAKE RIVERS ABOVE CELILO.

BY MAJOR J. J. MORROW.*

I. General Description of Columbia River above Celilo and Snake River to Head of Grande Ronde Rapids. From the head of Celilo Falls to the mouth of the Snake River, a distance of one hundred twenty-four miles, the Columbia has a total fall of 184.5 ft. (or 0.93 ft. per mile). Of this fall 86 ft. is concentrated over sixteen rapids having an aggregate length of nineteen miles with slopes varying from three feet per mile at Hells Gate to 8.3 ft. per mile at Devils Pend. The highest velocity is probably about ten miles per hour. The principal obstructions to navigation in this stretch are the swift water at rapids and shoal water at several places, the principal shoal being Homly Rapids where there is a depth of four and one-half feet at low water. Considerable work of removing boulders in the channels has been done so that the river is now fairly free of channel obstructions and can be navigated throughout the year except when closed by ice. A description of the river and various projects is given in the Annual Report of the Chief of engineers, 1877, p. 1038 and 1850, p. 2293, respectively, and in House Documents No. 238, 51st Congress, 1st session, and No. 440, 59th Congress, 2d session.

From the mouth of the Snake River to Wenatchee, Washington, a distance of one hundred forty-seven miles, there is one hundred and thirty miles of river that is now navigable at all stages, except when closed by ice, for boats drawing three to four feet. The seventeen miles of obstructed waters include Priest Rapids (nine and one-half miles in length, fall sixty-eight feet), Cabinet and Rock Island Rapids, seventy, one hundred twenty and one hundred twenty-five miles respectively from the mouth of the Snake River, where, at a stage of from twelve to fifteen feet above low water, navigation is possible, though difficult and dangerous. From the foot of Priest Rapids to the mouth of Snake River the river is in good navigable condition except for some shoals of minor character.

A low water channel cannot be obtained by open channel methods and canalization will be required at Priest and Rock Island Rapids. Plans for the improvement of this stretch of river, including canalization, are outlined in House Document No. 693, 62d Congress, 2d session, in House Document No. 440, 59th Congress, 2d session, and House Document No. 186, 47th Congress, 1st session.

From Wenatchee to Bridgeport, a distance of about eighty miles, the river has sufficient depth for navigation and the only obstructions are swift water and rocks and reefs in the channels. The average low water slope is 2.2 ft. per mile. Considerable open river work has been done and there is said to be a controlling low water depth of five feet in this stretch of river, so that navigation can be continuous throughout the year except when the river is closed by ice.

A description of this stretch of river together with improvements proposed is given in House Document No. 440, 59th Congress, 2d session, in the Report of

*Corps of Engineers, U. S. A.

the Chief of Engineers for 1895, p. 3534, and in House Document 186, 47th Congress, 1st session.

From Bridgeport, Washington, to Kettle Falls, a distance of one hundred sixty-two miles, the river is navigable for steamers at certain stages. The channel between Bridgeport and Hell Gate, seventy-five miles, is comparatively safe, but to complete the work will require the removal of much more rock than has been removed by open river work. It is believed that a channel through the obstructions up to Grand Rapids fifty feet wide and velocities up to ten miles per hour can be obtained by open river work which would be available for about six months in the year, but such a channel would not be of great benefit to navigation. Kettle Falls has a drop of thirty-three feet at low water and Grand Rapids, six miles below, has a fall of twenty feet.

Several projects have been considered for this stretch of river and are outlined in Chief of Engineers reports for 1893 and 1912, and House Committee Document No. 16, 60th Congress, 2d session. To put the river from the mouth of the Snake to Kettle Falls, a distance of one hundred eighty miles, in shape for commercial navigation, will require canalization in many places.

On the Snake River from its mouth to Riparia, sixty-seven miles, there is an average slope of three feet per mile and navigation is difficult on account of numerous rapids with swift currents and shoal water, which before improvement were practically impassable at low water. Open river work has been in progress more or less since 1876 and there is now a controlling low water depth of thirty inches. Owing to the shallow depths on the bars and in the rapids, the navigation season for steamers does not begin until the river reaches a three-foot stage at Lewiston gage (usually about March 10) and continues through the summer freshets until about July 1. From July to the following March the river stage is too low for navigation except for occasional short periods due to rains which usually fall in November. During the winter months the river is often closed to navigation by ice. A history of this stretch of river is given in House Document No. 411, 55th Congress, 2d session, House Document No. 127, 56th Congress, 2d session, and Annual Reports of the Chief of Engineers for 1877-1880, 1903 and 1906.

From Riparia to Lewiston, a distance of seventy-three and one-half miles, the river has an average slope of 2.67 ft. per mile, is in fairly good shape, has a controlling low water depth of four feet. Navigation is carried on almost throughout the year except through the winter months, when there is ice. There is no through commerce on this stretch of river. The Oregon-Washington Railroad and Navigation Company operates two boats for the transfer of wheat across the river. The improvement of this stretch of river is discussed in House Document No. 127, 56th Congress, 2d session, and report of Chief of Engineers for 1877 and 1892 and 1901.

The river from Lewiston to Grande Ronde Rapids, a distance of thirty-one miles, has a slope of 3.6 ft. per mile and there are several rapids which are difficult to navigate. The principal obstructions are swift water and boulders in the channels. Some open river work has been done and the river is in fair shape for commercial navigation to the foot of Wild Goose Rapids, about thirty-two miles above Lewiston. A description of the river, together with proposed improvement, is given in Report of Chief of Engineers, 1882, 1885, 1903 and 1905.

II. Navigation of the Columbia River above Celilo

Commercial navigation has existed on the Columbia and Snake rivers above Celilo, since 1858, when the steamer "Col. Wright" was built at Celilo and made a trip in June, 1860, up the Snake to Clearwater River and thirty-seven miles up the Clearwater. Lewiston, Idaho, was founded in 1860, and in 1863 the rush to the Salmon River mines in Idaho required greater transportation facilities than existed at that time and four additional steamers were built. By 1864 the fleet was increased to ten steamboats and the rates were as follows:

Portland to The Dalles	100 miles,	freight $15.00 ton,	fare $ 6.00
Portland to Umatilla	200 miles,	freight 45.00 ton,	fare 10.00
Portland to Lewiston	360 miles,	freight 90.00 ton,	fare 22.00

All of the above boats were 125 to 160 ft. long with beam from 24 to 31 ft. and 5 ft. depth of hold. In 1880-1881 two boats 200 ft. in length, 37 ft. beam and 6 and 7½ ft. depth were built at Celilo. All passengers and freight for The Dalles required a porterage at Cascades, and all for upper river points an additional porterage from The Dalles to Celilo. Navigation of the upper river declined rapidly from 1866 to 1870 and several steamers were taken over Celilo Falls to the lower river.

The boats mentioned all navigated the Columbia and Snake rivers. In 1867 the steamer John Gates made a trip up the Columbia River, passing over Priest and Cabinet Rapids and part way up Rock Island Rapids. Navigation of the Columbia River above the mouth of the Snake has been carried on intermittently on the various good stretches of river, but since the construction of the railroads there has been little navigation on the river above Priest Rapids. After completion of the Oregon-Washington Railroad & Navigation Company's line from Wallula to Portland in 1882, navigation of the upper Columbia and Snake rivers practically ceased. Novigation of the river above Celilo was not revived until 1906 when two small steamers were operated in connection with the Oregon State Portage Railroad which was constructed for the purpose of transporting freight from the foot of The Dalles Rapids to the head of Celilo Falls, during the construction of The Dalles-Celilo canal. In 1908 two large boats were built by the Open River Transportation Company to operate on the river above Celilo in connection with the Oregon State Portage Railroad.

The Open River Transportation Company suspended operations October 31, 1912, due to lack of patronage, and since that date there has been no through navigation on the Columbia and Snake rivers. The Oregon-Washington Railroad & Navigation Company operates two boats between Riparia and Lewiston, transferring wheat across the river, but does no other traffic. A gasoline boat operates on the Snake above Lewiston to Pittsburg Landing, seventy-five miles above Lewiston, during favorable stages.

It is believed that the opening of The Dalles-Celilo Canal will revive the navigation of the river, as it will permit continuous navigation from Portland to Wild Goose Rapids, thirty-two miles above Lewiston on the Snake River, and to the foot of Priest Rapids on the Columbia River.

The Columbia River above Priest Rapids will not be available for through navigation until Priest Rapids and some others are surmounted by canalization, so the only source of limestone available will be that existing on the Snake River at the head of Grande Ronde Rapids, about thirty-one miles above Lewiston.

The navigation season on the Snake is controlled by the stretch of the river between its mouth and Riparia where, on account of shoal water and swift currents, the navigation season is limited to river stages above three feet on the Lewiston gage and will not exceed one hundred days annually, say from March 15 to July 1. To handle 100,000 tons of limestone annually would then require an average daily movement of 1000 tons. Barge navigation on the upper Columbia and Snake rivers has not been tried as yet, but it is possible that a powerful steamer could handle two 500-ton barges of four foot draft on the river above Celilo with a river stage of more than three feet at Lewiston, and make a round trip in five or six days. The trip upstream with empty barges would probably be more difficult than the downstream trip with loaded barges. To handle 1000 tons daily for 100 days would require a fleet of say eight steamers and sixteen barges and the cost of transportation would depend upon the method of handling the work. A transportation company might make a contract for the work or the power plant have its own equipment. The cost of operating a river steamer of the type used on the upper Columbia River should not exceed $100 per day and this would, without overhead expenses, repairs, etc., make the cost of transportation 60c per ton where one steamer handles 1000 tons every six days. It is possible that 500 ton barges cannot be handled on the Snake River, so that the cost of transportation would be greatly increased if the size of the barges had to be cut down to say 300 tons, as one steamer would then handle only 600 tons in six days at a cost of $1 per ton for transportation, and the maximum annual tonnage would be only 60,000 tons unless the number of steamers and barges were practically doubled.

An approximate estimate of the annual cost of a plant to handle 100,000 tons, based on 500 ton barges would be as follows:

8 steamers at $60,000 each	$480,000
16 barges at $5,000 each	80,000
	$560,000

Operating and Other Expenses with Plant Owned by the Power Company.

	Annual		Three Months.
Depreciation, 10 per cent	$56,000		$14,000
Repairs, 10 per cent	56,000	say	20,000
Interest, 6 per cent	33,600		8,400
Overhead expense, say	20,000		5,000
Operating expenses, three months	72,000		72,000
Care of plant for nine months	15,000		
Total annual cost	$252,600		$119,000

The final cost would therefore be approximately $2.50 per ton for transportation if the plant were owned and operated solely for transportation from quarries at Grande Ronde on the Snake River. Of course it would be possible to use the plant on the Columbia River between Portland and Priest Rapids for commercial freight during the nine months when navigation on the Snake is closed and the cost for transportation would be cut down to about $1.20 per ton. The last named figure would probably represent the minimum rate at which a transportation company could afford to do the work and this only if organized on a large scale as outlined herein. It also is based upon the existence of conditions favorable for the use of a plant outside the short working season, which will probably not be true for some time to come.

It is not believed that any better figure could be arrived at by investigating the probable cost of operating looking toward constructing cheap barges at Grande Ronde and dismantling them at The Dalles. The supply of timber near the quarry is not sufficiently accessible to justify even a study along these lines.

CAUTION IN THE USE OF THE ELECTRIC IRON.

For the second time within two weeks the San Francisco papers have contained items wherein an electric iron has been carelessly left on and consequently burned through the ironing board, table, floor and ceiling, making its appearance in the room below.

It is a known fact that the electric iron is one of the greatest fire hazards that are to be found among the many electrical appliances of the modern householder. The public should as a consequence bear the fact in mind and use this wonderful little time saver and modern convenience with the proper precaution of turning the switch when its use is over.

OPERATING COSTS FOR ELECTRIC HOUSEHOLD APPLIANCES.

Here are some costs per hour to operate electric household appliances on a 7 cent per kw. rate, as reported by the Electrical Review:

Appliance.	Cents.
Electric washer	1.4
Vacuum cleaner	0.9
Iron	3.9
Toaster	3.2
Fan	0.4
Heating pad	0.4
Milk-bottle warmer	3.5
Percolator	2.7
Sewing machine motor	0.4
Grill	4.2
Chafing dish	3.5

With these figures as a basis the average cost of washing, ironing, sweeping, etc., for a family of six persons amounts to the following:

Operation.

	Cents
Washing, once a week, 2 hours' use of current	2.8
Ironing, 4 hours' use of current	15.6
Sweeping, thrice weekly, 2 hours' use of current	1.8
Sewing, 3 hours a week	1.2
Total	21.4

The cost of cooking for a family of six is:

	Cents
Broiled chops, saute potatoes (grill) (Both cooked at same time, 15 minutes).	1.05
Coffee (percolator), 15 minutes	0.6
Toast (electric toaster), 10 minntes	0.6
Total	2.15

DISCUSSION OF ALL THE VARIOUS FORMULAS FOR COMPUTING THE SKIN EFFECT.

BY CLEM A. COPELAND.

(In our issues of July 29th and August 5th, the author set forth certain formulas for computing the skin effect of solid and stranded cables. This discussion was followed by citing definite numerical examples. In this article attention is called to the fact that other formulas for computing the "skin effect" appear in standard reference books some of which should be used only under certain conditions while others are erroneous and should be avoided. Attention is also emphatically called to the fact that the "proximity effect" of cables is usually neglected in current formulas treating the subject while it is shown that this effect not only enters but often becomes the most important factor in the discussion.—The Editor.)

By investigating the relation between the argument $\varkappa$, and $\mathbf{K}_R$ in Table I it will be found that for low values of $\mathbf{K}_R$ the ($\varkappa$, $\mathbf{K}_R$) curve is parabolic in trend, whilst for high value it becomes practically a straight line, i.e., asymptotic. There are consequently, many formulae which fit the two kinds of curves involved, more or less closely and which may be used if judiciously applied within specified limits.

It is recommended however that all other formulae and tables be abandoned for the Kelvin treatment of the problem so satisfactorily expounded by Mr. A. E. Kennelly, inasmuch as the U. S. Bureau of Standards has given us a table of splendid merit, and the Kelvin treatment exhibits other useful and interesting phenomena in this connection. Furthermore, Kelvin's formulae as exhibited in equation (3) and Table I have been experimentally verified.

Moreover, not only do we obtain the value of $\mathbf{K}_R$ and $\mathbf{K}_L$ readily for any values of r_1, f and μ from zero to practical infinity but the mathematical derivation gives us a perfect mental picture of what actually goes on inside of the conductor.

In Fig. 1, as an instance, the cup shaped curve shows the maximum values of the current densities at various distances from the center of the conductor of Problem I, while to the right appear sinusoidal curves of the current at radii .475 in, .95 in., 1.425 in, 1.9 in. and 2.3751 in., lagging behind the current at the center by the angles there shown. One may calculate that at the time when the total current in the conductor is zero there are still currents flowing in opposite directions in different parts of the conductor. When the current at the surface is a maximum in one direction the current is almost zero at a radius of 1.9 in. and flowing in the opposite direction at a radius of 1.425 in.

Other interesting investigations may be made in great number.

As this is a critical discussion intended to point out the blind trails as well as the well travelled highways, the following well known and often misapplied methods may prove of value.

Probably the most familiar formula in this connection fitting the lower part of the ($\varkappa$, $\mathbf{K}_R$) curve is the infinite series,

$$\mathbf{K}_R = 1 + \tfrac{1}{12}\left(\frac{2\pi f \mu l}{\mathbf{R}_{dc}}\right)^2 - \frac{1}{180}\left(\frac{2\pi f \mu l}{\mathbf{R}_{dc}}\right)^4 + \cdots \quad (5)$$

wherein l is the length of the wires in centimeters.

This formula will be found on pages 67 and 334 of the "Standard Handbook for Electrical Engineers," acknowledgment being made to Gerard's "Lecons sur l'Electricite," Vol. 1, Page 236. This formula is also derived by Andrew Gray in "Absolute Measurements in Electricity and Magnetism," Vol. 2, part 1, pages 325 to 329, together with the allied and less familiar formula

$$\mathbf{K}_L = \frac{\mu\, 1}{2} - \frac{1}{48}\left(\frac{2\pi f \mu l}{\mathbf{R}_{dc}}\right)^2 + \frac{13}{8640}\left(\frac{2\pi f \mu l}{\mathbf{R}_{dc}}\right)^4 - \cdots \quad (6)$$

Formula (6) was also copied in an erroneous form on page 147 of our old familiar "Alternating Currents and Alternating Current Machinery" by D. C. and J. P. Jackson, wherein f should be replaced by $2\pi f$.

The formulae (5) and (6) are given in many different equivalent forms, the most common being their conversion to every day units from their above form in C. G. S. units. Thus

for 1 substitute 30.48 l;

for $\mathbf{R}_{dc}$ substitute $10^9\ \mathbf{R}_{dc}$; then

for $10^9\ \mathbf{R}_{dc}$ substitute $\mu\ 1/\mathbf{A}_{om}$ and reduce thus

$$\mathbf{K}_R = 1 + \frac{3.0}{10^{15}}\left(\frac{\mu f \mathbf{A}_{om}}{\rho_o}\right)^2 - \frac{7.5}{10^{30}}\left(\frac{\mu f \mathbf{A}_{om}}{\rho_o}\right)^4 + \cdots \quad (7)$$

in which $\mathbf{A}_{om}$ is the area in circular mils and ρ_o is the resistance of a mil-foot of the conductor.

From (7) various curves and tables have been made out giving the values of $\mathbf{K}_R$ for copper, aluminum and iron (erroneously) for various values of $f\mathbf{A}_{om}$.

This series is obtained by dividing one series by another, together with the assumption that $\pi r_1^2/\rho$ if small, (ρ being 1714.1 for copper at 20° C. while r_1 is in cms.) it has therefore been pointed out that (7) should not be used when $f\mathbf{A}_{om} > 10^8$ corresponding to $\mathbf{K}_R > 1.222$.

Thus a 1,666,700 cir mil copper rod at 60 cycles or a No. 0. B. & S. Gauge wire at about 945 cycles would approximately define the upper limit of the formula's accuracy.

Using another term in the series would result in raising the limit to $f\mathbf{A}_{om} = 1.8 \times 10^8$, corresponding to a 3,000,000 cir mil rod at 60 cycles or a 30,000 cir mil wire at 6000 cycles.

The "Standard Handbook" states (p. 280) that above $\mathbf{K}_R = 1.5$, formula (7) should be replaced by the approximate asymptotic formula:

$$\mathbf{K}_R = \sqrt{\frac{1.592\,\mu f \mathbf{A}}{10^8\,\rho}} + .26 \quad (8)$$

This expression pretty accurately fits the upper or straight line part of Kelvin's curve.

Another formula cited by Steinmetz estimates the equivalent depth of current in flat conductors as

$$\mathbf{S} = 5030\sqrt{\frac{\mu f}{10^9 \rho}}$$

This of course is only applicable to very large cylindrical conductors, in which case

$$\mathbf{K}_R = \frac{r_1^2}{r_1^2 - (r_1 - \mathbf{S})^2}$$

On page 148 of "Alterating Currents and Alternating Current Machinery," by D. C. and J. P. Jackson (1896), one finds the following statement:

"* * * the frequency or the diameter of the wire may be so great that no current at all will flow at the center of the conductor, while if the frequency is very great the current will all remain at the exact outer surface or skin of the wire."

This is evidently true at only one particular instant of time or for one particular value of $\varkappa$ at all times.

In nearly all discussions in text books, hand books and various papers, it is worthy of note that the "proximity effect" is not mentioned.

Curiously enough the "proximity effect" is the most important part of the whole discussion because in large conductors where skin effect becomes prominent, engineering conditions usually dictate that they be near together, as in "duplex" and "triplex" or three-phase cables or in busses and leads to electrolytic sinks and electric furnaces.

Various Other Forms of Conductors.

Mr. Kenelley has presented a voluminous amount of experimental data on the skin effect in rectangular and tubular conductors in various relative positions with respect to each other, while the U. S. Bureau of Standards has given us complete data on the effect in bimetallic wires. These two papers together with the data collected and enlarged upon used in connection with handbooks are considered quite satisfactorily complete for present uses.

MAKING AMERICANS OF FOREIGN-BORN WORKMEN.

The Chamber of Mines and Oil, a live organization recently established in Los Angeles to promote the interests of production of crude petroleum in the southwest, has taken up the subject of making Americans of foreign-born workmen. The subject is a broad one and aside from its patriotic aspects vitally interests all large employers of men.

The secretary of the National Amalgamation Committee, Mr. F. A. Kellor, sattes that during the past year there has been for obvious reasons a distinctly increased interest in American citizenship as affecting foreign-born workmen. The Federal Bureau of Education, the Bureau of Naturalization, the National Chamber of Commerce, through its recently appointed Immigration Committee, and various local chambers of commerce, and other agencies in cities throughout the country have definitely assumed the responsibility of promoting the use of the English language and American citizenship among the foreign-born workmen and women throughout their cities. Usually this has been done as a matter of direct co-operation with the public night school system.

The co-operation of the employer has been, in all these efforts to promote Americanization on a community scope, a fundamental necessity. In Detroit, Syracuse, Rochester, Youngstown, Wilmington, Delaware, Minneapolis, and elsewhere it has been the organized interest of the chambers of commerce in the work that has given solidity to the movement.

STANDARDS FOR ELECTRIC SERVICE.

BY U. S. BUREAU OF STANDARDS.

The U. S. Bureau of Standards in its Circular No. 56 has just issued an important code of standards for electric service. Copies of this publication may be procured from the Superintendent of Documents, Government Printing Office, Washington, D. C., at forty-five cents per copy. The circular in all contains 262 pages of reading matter and will prove of inestimable value to utility companies, regulating commissions and others interested in the standardization of electric service.

The regulation by state commissions of public service utilities other than common carriers is becoming more widespread yearly. Less than 10 years have elapsed since the first state commissions were created, yet regulation has already been established by law in greater or less degree in 30 or more states. It is now generally recognized that the supply of electric service is a natural monopoly, and should therefore be regulated by the state or by the municipality.

The intelligent and fair regulation of any utility requires a thorough knowledge of the elements that together constitute good service. It also requires a knowledge of what it is possible to supply at a given cost or what the increased cost will be if the service is improved in any particular respect. The Bureau has studied some of these questions with respect to gas service, and its publication, Standards for Gas Service, is now in its third edition, there having been a very great demand for it from gas engineers and other representatives of the gas industry and also from public service commissions and city officials. The time now seems ripe for the publication of a similar study and discussion of the subject of electric service.

The supply of electric energy from central stations for electric light and power had its first beginnings a little over 35 years ago. Marvelous advances have been made since then in the generation, distribution, and utilization of electrical energy, but the question of standards of service has been to a large extent ignored, due partly to the rapid growth and development of the industry and partly to the absence of any suitable agency for making a thorough study of the subject. The National Electric Light Association and the Association of Edison Illuminating Companies have done excellent work for years on the subject of meter specifications, but have not attempted to set standards of service.

A number of state commissions have adopted rules and recommendations for electric service regulations which, however, vary considerably in their requirements. This makes it desirable to collect and compare the provisions of such state rules and to propose such standards as may be applicable generally.

A number of cities in states not having regulating commissions have established municipal commissions and inspection bureaus. The Bureau of Standards has co-operated with certain of these, as well as with state commissions, and has been to a certain extent a clearing house of information with reference to the important questions of standards and accepted good practice.

This circular attempts, therefore, to present a survey of the general field of state and municipal regulations in so far as standards of electric service are concerned; and presents suggested rules and regulations which may be adopted as proposed or which may form the basis for rules and ordinances to be adopted by states and cities.

Criticisms and suggestions on this circular are desired from all interested persons, especially from commissioners and engineers of commissions, public utility operators and engineers, committees of technical societies, municipal commissions, municipalities, and operating companies. The bureau is ready to assist to the fullest extent in the establishment of standards and the promotion of a good understanding between regulatory bodies, operators, and customers.

In order that the readers of the Journal may get a comprehensive idea of the scope of this important work we append herewith a full detailed list of the subject matter treated:

Introduction.

I. The Adequacy and Safety of Electric Service.
- A. Electric service standards.
- B. Factors influencing adequacy of service.
  - 1. Central station operation.
    - (a) Adequate power and generating capacity; (b) Regulation of generating apparatus; (c) Switchboard instruments; (d) Station records.
  - 2. Distribution systems.
    - (a) Voltage regulation of feeders and mains; (b) Transformer and secondary main losses; (c) Efficiency of distribution.
  - 3. Meters.
    - (a) Accuracy requirements for watthour meters; (b) Installation and testing of metals.
  - 4. Customers' utilization devices.
    - (a) Incandescent lamps, Voltage and frequency effects, Supervision of lighting service; (b) Motors; (c) Heating and other devices.
- C. Safety of electric service.
  - 1. General statement; 2, Grounding low potential circuits; 3, Commission jurisdiction and procedure with reference to accidents.

II. Meters and Instruments.
- 1. Facilities for meter testing.
- 2. The approval of types of meters.
- 3. Suggested specifications governing approval tests of types of electricity meters by State commissions; general provisions for the approval of types of watthour meters by the commission; Specifications for design and construction; Preliminary preparation of meters for tests; Conditions governing the approval and rejection of types; Specifications for the testing of direct current watthour meters; Specifications for the testing of single-phase induction watthour meters; Specifications for the testing of polyphase watthour meters.
- b. Amperehour meters.
- 5. Demand meters.

III. Standardizing Laboratories of State Public Service Commissions.
Description of commission laboratories.

IV. Rules and Regulations for Electric Service as Adopted by State Commissions.
Abstract of titles of state rules; Accidents; Allowable errors of meters; Application of rules—Definitions; Commission inspections, tests and laboratory; Complaints; Creeping meters; Deposits to insure payment of bills; Discontinuing service; Extension of lines; File of schedules of rate, rules and regulations; Fraudulent use; Frequency variations; Grounding of secondaries; Information for customers as to service; Inspection of distribution systems and apparatus; Inspection of lamps and lamp renewals; Interruptions of service; Maintenance and contruction; Meter installation tests; Meter location; Meter readings for customers; Meter readings on bills; Meter rentals; Meter testing equipment; Meter test methods and place; Meter test records; Periodic test of meters; Pole identification and inspection; Referee or commission tests—fees; Refunds and bill adjustments; Replacement of meters; Reports and records; Request tests by customer; Station records; Voltage surveys; Voltage variations.

V. Suggested Rules for the Regulation of Electric Service by State Commissions.

VI. The Regulation of Electric Service by City Ordinance.
List of cities.
Charleston, C. S.; Chicago, Ill.; Cincinnati, Ohio; Grand Rapids, Mich.; Harrisburg, Pa.; Kansas City, Mo.; Los Angeles, Cal.; Louisville, Ky., Memphis, Tenn.; Minneapolis, Minn.; Norfolk, Va.; Providence, R. I.; Sandusky, Ohio; San Francisco, Cal.; Sioux City, Iowa; St. Louis, Mo.; Topeka, Kans.

VII. Suggested Ordinances for the Regulation of Electric Service in Towns and Cities.
1, For towns and small cities; 2, For cities generally; 3, For larger cities.

Appendixes.

Appendix 1.
1. Summary of state laws now enacted providing for the regulation of electric service.
List of statutes covering subject of electric service.
2. Summary of laws relating to accidents and safety provisions under the jurisdiction of public service commissions.

Appendix 2.
Tables.
1. Maximum watthour meter errors allowed by commission regulations; 2, Maximum watthour meter errors allowed by city ordinances; 3, Maximum watthour meter errors allowed by statute; 4, Periodic meter tests, N. Y. P. S. C., first district; 5, Periodic meter tests, N. Y. P. S. C., second district; 6, Complaint meter tests, N. Y. P. S. C., first district; 7, Meter accuracy improvement; 8, Meter accuracy by types; 9, Meter sizes on a typical system; 10, Voltage regulation requirements; 11, Central station statistics; 12, Municipal central station statistics.

Appendix 3.
Rules and regulations of Maryland Public Service Commission, February 1, 1916.

Appendix 4.
Chicago ordinance, July 15, 1915.

Appendix 5.
California Railroad Commission, Case 683, Dec. 1, 1915.

Appendix 6.
Selected bibliography.

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FINAL REPORT ON THE COLUMBIA RIVER POWER PROJECT.

BY BOARD OF REVIEW.*

Honorable Franklin K. Lane,

Secretary of the Interior, Washington, D. C.

Sir: Your Board of Review appointed under instructions received through the Director of the Reclamation Service bearing date of October 28, 1914, was directed to consider and to review the report on the project for the development of power on the Columbia River at The Dalles, Oregon, prepared under the direction of and by certain engineers of the U. S. Reclamation Service and the state of Oregon, pursuant to an agreement between the Department of the Interior and the state of Oregon dated December 12, 1913.

These instructions indicated the scope of the desired review as covered by the terms of the contract executed between the U. S. Government, represented by the Reclamation Service, and the state of Oregon, and relating to the investigation of this problem.

From this contract we quote as follows:

"That surveys and investigations be made in that portion of the States of Oregon and Washington leading to the preparation of detailed plans, specifications and estimates of cost for the maximum economical development of waterpower in the Columbia River, near The Dalles, at what is known as Five Mile Rapids."

In accordance with these general instructions, your Board assembled at The Dalles, Oregon, on November 19, 1914, and spent most of the day in an examination of the physical features at and near the dam and power sites. The Board then returned to Portland, and during the following days considered the above mentioned report, together with the maps, drawings and other data relating to the project and on file at the office of the Reclamation Service.

The project in general terms involves the control of the entire flow of the Columbia River at a point near The Dalles, Oregon, the construction of a power canal, and the erection of a power house at a point about one and one-half miles below the point of control. The quantity of water involved will vary between about 30,000 second feet minimum and some 1,170,000 second feet maximum. The head for plant operation will vary from a minimum of about 45 ft. under usual flood condition to 105 ft. under low water flow. The power which can be developed continuously twenty-four hours per day and 365 days in the year will aggregate about 480,000 electrical horsepower, with the possibility of the development of additional large blocks of power for a part of the year, all as shown in detail in the main report.

In considering a project of this character we may advantageously subdivide the question under three heads:

(1) Engineering feasibility;

(2) Cost, assuming engineering feasibility;

(3) Commercial feasibility.

*Secretary of the Interior Franklin K. Lane appointed a board to consider the foregoing investigations of the Columbia River Power project and to report thereon. The personnel of the board was as follows: Brigadier-General W. L. Marshall, Ex-Chief of Engineers, U. S. Army and Consulting Engineer to the Secretary of the Interior, chairman; other members were: Ralph Modjeski, Consulting Engineer, Chicago, Illinois, and Portland, Oregon; W. F. Durand, Professor of Mechanical Engineering, Stanford University; and D. C. Henny, Acting Chief Engineer, U. S. Reclamation Service. The report was filed with the Secretary of the Interior on Nov. 21, 1914.

Engineering Feasibility.

Examination of the proposed site, together with the detailed studies presented in the main report, show that the principal technical problems center around the following features:

(a) The closure of the present channel;

(b) The provision of suitable control gates for flood conditions;

(c) The main power canal;

(d) The power house and generating machinery.

Of these, the last two present no features of unusual difficulty. The character of the work is plain and straightforward, and permits of direct comparison with a large amount of work on other projects of an entirely similar character. Neither of these features seems likely to present any problem of a difficult or controlling character in relation to the project as a whole.

With regard to items (a) and (b), the problems are somewhat beyond direct precedent, both in magnitude and character. The main report presents in detail a discussion of these problems, together with suggestions of several alternative methods through which the work may be carried out, and with the suggestion of the need of still further study before attempting to adopt a final and definite solution.

In our judgment the engineering feasibility of the project as a whole will be determined by the question of these two items, which must be viewed as the controlling engineering problems. We are, however, of the opinion that the present resources of engineering art offer every reasonable assurance of a possible and practicable solution. We believe further that some one or another of the various methods suggested in the main report might reasonably be expected to furnish a possible solution. We are not prepared, however, to endorse any one of these methods as presumably the best possible, nor do we believe that any such final choice of method should be made in advance of further detailed study and investigation. It should be noted that this opinion is in entire accord with the conclusion of the main report.

Cost.

In the brief time at our disposal we have not been able to make any detailed review of the estimates of cost. We have, however, noted carefully the various unit costs employed, and have given special consideration to the resulting cost of certain of the larger items.

We are prepared to endorse as reasonable the general schedule of costs thus resulting from these various unit prices, and, while in making a detailed estimate ourselves we should be inclined to modify certain items, the influence on the total would be relatively inconsiderable.

Broadly speaking, we believe that the project as an engineering construction could be completed to the point contemplated in the outline designs submitted in the main report for a sum which may, including interest at 6 per cent during construction, approximate $55,000,000.

Commercial Possibility.

The intelligent study of this part of the subject requires consideration of the following:

(1) The present demand for electrical power in the territory which can be considered as tributary to this project and the probable rate of growth of such demand under normal conditions;

(2) The extent to which the demand for electrical power may permit of building up in large blocks by the establishment of special industries;

(3) The most economical sources of power to meet advancing demand in this territory, in accordance with any assumed probable or possible rate of growth, and having in view a wise public policy with reference to the conservation and development of our natural resources.

(4) The economic results to be anticipated, assuming the proposed plant to be built as contemplated, and with such an estimated rate of growth of paying load as might be considered probable.

The main report presents a large body of valuable matter bearing on topics (1) and (2), the present and future prospects regarding the market for power. With the general conclusions reached therein we are in entire accord. We do not consider that the growth of the power demand under normal conditions would be sufficient to absorb the output of the proposed plant until after the lapse of an uncertain but considerable period of years. We consider, furthermore, having in view the present state of the art, with regard to the electro-metallurgical and the electro-chemical industries, as well as the conditions with regard to the location of this plant in relation to raw materials and immediate market, that there is no present prospect of the building up of a demand for power in this territory in blocks which might represent any large fraction of the total output.

Again, while we have had no opportunity of examining the point in detail, we are prepared to state, on the basis of facts well known in the history of the development of water power in this general territory, that for some years to come the normal growth in power demand can be met most economically by additions to existing plants now only partially developed, or by the development of small projects more nearly proportional to the power which is likely to be required in succeeding years.

Reference to the technical problems involved, as shown in the main report, indicates that it is not possible to make the necessary hydraulic development by stages, and the schedule of costs will show that the necessary capital investment before any power whatever can be produced in the proposed plant will approximate from $35,000,000 to $40,000,000. In these circumstances it follows that unless a paying load approximating close to the full capacity of the plant is ready immediately upon completion, the annual fixed charges will exceed the income, and a deficit will begin to accumulate, which must be met by further borrowing; thus constituting an addition to the capital account until such time as the plant may become self-supporting.

By way of illustration we have assumed a period of ten years during which at a uniform rate of growth such total load might be acquired.

Computation shows that on a three per cent interest basis the accumulation of deficit during these years of development of business may cause the aggregate investment at the end of the tenth year to reach $61,000,000. On a four per cent interest basis this aggregate may be $63,000,000, while for six per cent securities discounted ten per cent and assuming deficits to have been met by additional bond issues, the face value of the bonded indebtedness at that time may reach $78,000,000.

Such ultimate growth of the capital investment will cause corresponding increases in the prices at which power must be sold to the consumer as compared with prices based on capital representing the cost of the physical property alone.

Any project of the character and magnitude of that under present consideration should be provided at the start with a load closely approaching its ultimate output, otherwise the losses during the early years of development of business will entail large additions to the capital account and corresponding increase in the prices at which power must be sold.

It appears that there is no present commercial demand which at possible prices of power as shown in the main report, Appendix I, could justify the immediate development of this project, nor can we see any prospect of any such demand in the immediate future, and we therefore conclude that the development of the project can not be economically justified at the present time.

The commercial feasibility of this project must be judged in relation to the comparative cost of other large undeveloped projects in the West. No broad comparison can at present be made. It is self evident, however, that, broadly speaking, the construction of this project should not precede but should follow the development of cheaper power. The cost figures in the main report render it probable, however, that at some time in the future a definite commercial demand for this project may exist, and its development under such conditions will most notably add to the industrial wealth of the adjacent territory.

In closing we desire to express our high appreciation of the large amount of work which the authors of the main report with their collaborators and assistants have accomplished in a limited time, and of the thorough and careful study which these various problems have received at their hands.

Respectfully,

W. L. MARSHALL,
Consulting Engineer to the Secretary of the Interior.

RALPH MOJESKI,
Consulting Engineer.

D. C. HENNY,
Acting Chief Engineer, U. S. Reclamation Service.

W. F. DURAND,
Prof. of Mechanical Engineering, Stanford University.

SPARKS—CURRENT FACTS, FIGURES AND FANCY

From Southern California comes the news that "cooking by wire" is gaining in popularity. Two transmission line short circuits were recently caused by birds dropping snakes across the line. Needless to say the snakes were beautifully roasted.

* * *

In the last eighteen months gold has been imported in the United States to the extent of $688,877,000. According to our population of 100,000,000 we are all about seven dollars richer.

* * *

And now it is reported that some enterprising American dentist, armed with the latest electrical dental appliances, has gone to the "new Russia" to open an office, calling himself "Painlessky Pulliyotusky."

* * *

We trust that he will not become so fascinated with the native Vodka that his American friends later may be tempted to call him "Casky-whisky."

* * *

More than ten thousand miles of macadam roads have been ordered built in Afghanistan since the ruler of that country became the owner of an automobile. He must be some speeder.

* * *

In America we like to travel by automobile also. In 1905 there were only 48,000 motor-cars, while in 1915 there were 2,445,664.

* * *

A committee of thirty appointed to study the question of storage of flood waters on the Kings River in the San Joaquin Valley reports that abundant storage capacity is available for the conservation of more than six hundred thousand acre feet at a cost of about ten dollars per acre foot, and that this would furnish ample irrigation for more than a million acres of land.

* * *

Even South Africa hopes to put itself on a commercial basis in certain electrochemical industries. Agriculture and mining now require annually about $10,000,000 worth of chemicals, all of which are imported in form of fertilizers, cyanide and nitrates. Cheap electricity, abundant coal, limestone, and the necessary labor—essential elements for producing these compounds—all exist in South Africa.

* * *

Unusual commencement exercises were held recently at the Kansas penitentiary at Lansing. Thirty-one inmates of the big prison became graduates of the Kansas Agricultural College and received the same diplomas from the college that the boys and girls had received at Manhattan a week previous.

* * *

Ceramic engineering, including the science and practice of porcelain factories making electrical insulating materials, is to be taught in a new department at the University of Illinois, Urbana.

Heating and cooking rates of five cents per kilowatt hour, or less, in 3250 communities, are on file in the office of the Society for Electrical Development. About 70 per cent are 4 cents and under, and 30 per cent are below 3 cents.

* * *

American enterprise suffers in Buenos Aires due to the existence of lower freight rates to European countries, although the distance to New York is shorter. Recently an American firm lost a $3,000,000 contract due to this discrimination in rates, enabling European competitors to underbid.

* * *

A corporation called the Sociedad Recandadora de Impuestos was formed in Peru in 1895 with a capital of $973,300. Its purpose is to assist the government in the collection of taxes.

* * *

The traditional Kentucky Colonel may have value but listen—the export trade in palm kernels for 1913 from the British possessions was valued at $25,000,000.

* * *

The output of dynamos, including parts and supplies in 1914 was valued at $23,333,437, an increase of 34.8 per cent over the corresponding value five years previously.

* * *

In the recent disastrous floods in North Carolina the physical connections of long distance high voltage transmission lines of several independent power corporations in Aabama, Tennessee, North Carolina and Georgia saved the day so far as electric service was concerned. It's an old saying but a true one: "Hang together or you may hang separately."

* * *

As a safety precaution the Kansas Railway carries on each of its cars a tail lamp with a 10 in. glass lens. When the trolley energy supply is interrupted the tail lamp and markers are automatically lighted from a storage battery.

* * *

President Wilson has signed a bill appropriating $75,000,000 for federal-aid highways. It has been estimated that during the next five years $1,500,000,000 will be expended by state, county and federal government.

* * *

It is said that a very small quantity of ether inserted in the cylinders of a gasoline engine will enable the operator to start in cold weather on a quarter turn. "Ether" do this or use more arm-power. This is a bum joke and apologies are hereby made.

* * *

Electrical dealers should be careful of punctuation for display signs in their windows. Here is one from an apartment house: "Please knock bell out of order."

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A New and Promising Power Load

During recent years the electric pumping load for large Western power companies has exceeded the fondest expectations of former days. It is interesting to see how widely extended the application of different classifications of pumping load have now become. The latest diversion of electric power to this field of activity is to be found in the rice fields of California.

Five years ago the agricultural possibility of rice growing in California was an unknown quantity. Two years ago it became recognized as a possibility while today that rice can be grown to economic advantage in California is an established fact.

Last year for instance one company in California, putting under cultivation 3200 acres, produced 140,000 sacks of rice. These hundred pound sacks each wholesaled for $1.80. So it is at once seen to what prosperous totals this new agricultural possibility lends itself. This particular crop for instance netted the owning company about forty dollars per acre.

From the power salesmanship point of view, this new agricultural pursuit is creating a most desirable load. Rice can be most economically grown in California by using large acreages. The pumping season for irrigation lasts from April 15th to September 15th and during this period the load is practically constant, consequently low power rates are commercially possible. Notwithstanding the fact that a one cent per kw.-hr. rate is often granted for this class of pumping, nevertheless, the power bill for one consumer's rice fields detailed on another page in this issue total some fifteen hundred dollars per month.

It is not known as yet what acreage may eventually prove possible for rice production in the San Joaquin Valley and other valleys of the West but it is known that in the Sacramento Valley alone over one hundred thousand acres of first class rice lands exist. As a consequence of this bright outlook for rice production in the West, the power companies are again to be congratulated upon the opening up of a new and profitable classification of electric pumping service.

Stone Age Laws for Navigable Streams

One of the main points of difference between the navigable stream power development bills which have passed the Senate and the House is the requirement as to the construction of locks and other aids to navigation. The Senate bill requires that these be built in accordance with the specification of the Secretary of War at the time the dam is built. The House bill calls for such locks as the Secretary or Congress may "at any time" deem to be necessary, thus introducing an indefinite risk which capital will not assume. This difference is a serious obstacle to any compromise legislation that the joint conference committee may reach before the present session closes.

The great fault with the existing laws regulating hydroelectric development is the uncertainty as to terms. A liberal interpretation might make develop-

ment possible where the likelihood of the contrary deters investment. So in this one instance, at least, the understanding should be specific so that the facts may be known at the start.

This lock construction requirement in both bills, however, is based on a misunderstanding, a relic of the time when navigation was the highest use to which water could be applied. That day and age is passed. Today, water is more useful for irrigation, domestic supply and power development than for navigation. Even where streams are navigable most of the traffic is handled otherwise. Except as a big stick for enforcing lower rates comparatively little use is made of the navigable streams of the United States, and even this limited use is on the decrease.

More than eight hundred million dollars has been appropriated by Congress during the past fifty years for improving the rivers of the country. This is hardly a drop in the bucket as compared to what is necessary to make the fifty thousand miles of navigable streams fit for commerce. As few of these river improvements are self-supporting any plan whereby private capital will help carry the burden is most appealing.

If river navigation were still the chief economic need of the country there would be no doubt as to the wisdom of such a plan. But in the West, today, irrigation and power development are paramount to navigation. Many more people will be benefitted by watering the semi-arid areas than will be helped by river transportation. Water withdrawn for irrigation is naturally not available for navigation, but in view of the principle of "the greatest good to the greatest number," who can question the wisdom of such a diversion?

It seems the height of economic folly to hamper irrigation and power development in order that unneeded and unused navigation facilities be provided. Yet this is the basis whereon the War Department exercises control over many streams suitable for power purposes.

In the stone age waterways were needed. In this electric age they are not. The laws governing water usage have failed to keep up with modern modes of transportation. Let burdensome requirements be eliminated from irrigation and power projects in order that the march of progress not be halted.

Prohibitive Power Development

Another instance is chronicled in this issue of the Journal wherein a vast power development is thought inadvisable for the present due to the prohibitive interest charges that would ensue upon unused equipment in the first years of power applications.

It is estimated that the great power project at The Dalles on the Columbia River may be made to generate 365 days in the year, a total of 480,000 electrical horsepower at a cost of $55,000,000. The figure in itself would present a remarkably attractive proposition were the market fully developed for its utilization. Since, however, the market is not developed it is estimated that before the sales for this enormous power could be reasonably depended upon the interest charges would run the cost of the project up to some $73,000,000, thus making it prohibitive.

An emphatic moral is to be drawn from this report on the Columbia River Power Project. Too often have ultra conservationists scandalized the costs of power and income to be derived from its sale when certain private companies are undertaking to open up a new field of hydroelectric development without taking this important factor into account. In other words, too often does the public, unfamiliar with the long years necessary in nurturing a power development into a paying proposition, overlook the fact that years and years of careful studying of market conditions and encouraging of new industrial activities must ensue before the power company as a rule can come into its own and reap the harvest to be acquired by operating under a reasonably high load factor.

Let the public, then, and its regulating commissions, take from this lesson on the Columbia a more lenient attitude toward the utility companies and the risks involved in development of hydroelectric power and its markets.

Social Insurance

Social insurance in its broader aspects attempts to establish on an equitable basis a system of insurance operative not only in case of death but in the event of the sickness, invalidity, old age or even unemployment of the wage earner. The countries of Europe prior to the present international war had all practically established some system of social insurance for those wage earners whose annual incomes were less than from $1200 to $800. In some instances as in England the state enters with the employer and employe in maintaining the necessary funds while in Germany and other countries the funds are created and maintained by the employer contributing one-third and the employe two-thirds.

In the United States, California has perhaps been the most progressive in this matter, having already established what is known as a social insurance commission.

That many Western power companies have long since voluntarily established or encouraged many of the strongest features of social insurance through their local get-to-gether organizations is most commendable. In its broadest aspects the entire proposition is one that, when kindly and sympathetically treated pays big returns to the utility company. But the matter demands more than a charitable consideration. Fundamentally its principles are sound and deserving of the most thoughtful consideration by all. Upon the happiness and welfare of the wage earner depend practically the happiness, welfare and prosperity of the entire body politic. Anything that can be made to scientifically lessen the seasons of sickness, invalidity, old age or unemployment of the deserving wage earner is to be commended in its highest terms. Indeed its principles are so broad that the state itself should take a hand in seeing to its proper solution.

PERSONALS

A. J. Myers, Pacific Coast manager Wagner Electric Manufacturing Company, is at Los Angeles.

Wynne Meredith, member of the firm of Sanderson & Porter, is at San Francisco for a few days from Oklahoma.

Raymond D. Keyser, of the Great Western Power Company at Napa, was in San Francisco this week on business.

Otto J. Hawley, of the Great Western Power Company at San Francisco, has just returned from a short vacation in the East.

Kiyo Sue Inui addressed the Pacific Service, N. E. L. A., on the subject of "A Glimpse of Japan," on August 8th at San Francisco.

C. E. Heise, manager Westinghouse Electric & Manufacturing Company, at San Francisco, is spending his vacation at Santa Cruz.

J. E. Bridges has recently been appointed meter specialist for the San Francisco office of the Westinghouse Electric & Manufacturing Company.

Fred Nelson, of the Great Western Power Company at Oakland is spending his vacation with his family motoring through Southern California.

F. S. Myrtle, publicity manager Pacific Gas & Electric Company, is author of the play to be presented at the Bohemian Club jinks this year.

L. J. Brown, lamp salesman with the Western Electric Company at San Francisco, has returned from the Sunbeam lamp conference at Nela Park, Ohio.

Carl Young, general manager Illinois Electric Company, Los Angeles, leaves this week to visit the Chicago office and to attend the lamp conference at Cleveland.

Waldo C. Cole, salesman with Westinghouse Electric & Manufacturing Company, has been placed in charge of the publicity division of the company's local office.

T. W. Simpson, Pacific Coast manager Federal Sign System (Electric), was at Portland during the past week, having returned to the Pacific Coast from an Eastern trip.

H. F. Hofland, Pacific Coast manager Simplex Electric Company, has returned to Los Angeles, after disposing of the electric heating stock formerly carried by the Telephone Electric Equipment Company.

B. M. Rastall, who is making an industrial survey for the Chamber of Commerce at San Francisco, was the guest of **S. V. Walton** and **H. P. Pitts** in a trip throughout the San Francisco bay region during the past week.

W. B. Burbeck, of the sales department of the Pacific Gas & Electric Company, is sergeant of the signal corps company from San Francisco at the Mexican border. He has formed a club among Stanford graduates in the militia.

Carl E. Johnson, general manager U. S. Electrical Manufacturing Company of Los Angeles, has returned from a trip to the various electrical centers of the East, where he has been making a study of production methods, material and supply conditions, etc.

O. W. Peterson recently resigned his connection with the Turlock-Modesto irrigation project to take charge of new construction on the Lake Spalding dam of the Pacific Gas & Electric Company, under the direction of **P. M. Downing,** engineer of maintenance and operation.

S. E. Gamble, district manager of the Great Western Power Company at Petaluma, has resigned in order to give more time to the development of some of his own patented inventions. **George Bernhard,** assistant manager at Sacramento, has been promoted to the managership at Petaluma.

Joseph A. West, formerly chief engineer of the Ogden (Utah) Rapid Transit Company and the Ogden, Logan & Idaho Railway, has been appointed chief engineer of the Sumpter Valley Railroad of Oregon.

S. Blackley, general manager Trumbull & Jones, Ltd., of Melbourne, New Zealand, was at San Francisco during the past week, en route to Pittsburg and Manchester, England, whence he will return to New Zealand early in January. His company represents the British Westinghouse Company in the Antipodes.

C. R. Murray, salesman for the Western Electric Company in the San Joaquin Valley of California, has been unable to be on the job during the past month because of trouble with his eyes. However, he is expected to be out again in a couple of weeks. Meanwhile **R. E. Dryer,** assistant power apparatus salesman, is covering Mr. Murray's territory.

W. W. Briggs, general agent Great Western Power Company, is spending his vacation on the Russian River, and incidentally taking in the jinks at Bohemian Grove. **H. F. Woodward,** district manager at Oakland, is temporarily looking after Mr. Briggs' work, while **J. B. Black,** of the general office, is attending to Mr. Woodward's duties in Oakland.

H. V. Carter, whose resignation as president and general manager of the Pacific States Electric Company was recently announced, is one of the old-timers in the electrical business in the West. Coming to Los Angeles from Canada in 1887, he was first associated with the Los Angeles Gas Saving Asso-

H. V. Carter.

ciation. In 1893 he started his career as a central station man by installing a 30 kw. steam generating plant at Santa Monica, the nucleus of the United Gas Light & Power Company which was later merged into the Southern California Edison Company.

Together with the late Frederick H. Rindge and Geo. I. Cochran he then bought the Long Beach steam plant and also a small plant at Redondo, built a large steam generating station at Santa Monica and a 23,000 volt transmission line which supplied current to Sawtell, Inglewood, Redondo, San Pedro and Long Beach. At about the same time he installed a small hydroelectric plant in connection with the water supply of Monrovia and furnished current for that town. About 1896 Mr. Carter bought the plants of the Santa Barbara Gas & Electric Company, rebuilt and enlarged both the gas and electric generating stations; purchased the Santa Barbara

Street Railway and erected a $40,000 bath house as a terminal attraction. This combination made a most attractive proposition and Mr. Carter has often been heard expressing regrets that he parted with his Santa Barbara holdings.

In 1900 this and the other companies operated by Mr. Carter under the name of the United Electric Gas & Power Company were merged in the Southern California Edison Company.

Meanwhile Mr. Carter had become interested in and was made president of the Pacific Electrical Works, a large wire insulating mill operated in Los Angeles whose capacity far exceeded the coast demand.

With the relinquishment of his central station duties Mr. Carter took up this losing proposition, gradually converted it into a supply house and in eight years' time built it up into a profitable jobbing house. In August, 1909, the Pacific Electrical Works of Los Angeles was merged with the Sterling Electric Company of San Francisco and the Crescent Electric Company of Oakland to form the present Pacific States Electric Company, with H. V. Carter, president and general manager and W. L. Goodwin vice-president and sales manager. Under this capable and energetic management the company is now doing the largest electrical supply jobbing business in the Pacific Coast, stores being operated at Seattle, Portland, Oakland, San Francisco and Los Angeles. This interesting bit of biography is an essential part of the electrical history of the West. Mr. Carter's present retirement comes in connection with disposing of all his holdings in the company and closes another chapter in an eventful life.

Colonel Carter has numerous other interests, especially in Southern California, being vice-president of the Seaside Water Company and the Long Beach Bath House & Amusement Company. He is also a director in the Seaside Investment Company, which owns the beautiful Hotel Virginia.

His many friends are now wondering what he will do next, but this, like the manner of acquiring his military title must for the present remain a matter of speculation.

PROGRAM PACIFIC COAST CONVENTION OF THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

September 5, 6, 7, 8.

Tuesday, September 5th.—Morning Session.

10:00 a. m.—Registration; Opening of Convention.

11:00 a. m.—Address of Welcome; Response; Address, President H. W. Buck; Paper, A Distribution System for Domestic Power Service from Commercial and Engineering Standpoints, by Carl H. Hoge and Edgar R. Perry.

Afternoon Session, 2:00 to 5:00.

Paper: Some Features of Domestic Electric Cooking and Heating, by H. B. Pierce; Paper: Temperature Rise of Insulated Lead Covered Cables, by Richard C. Powell; Discussion.

Wednesday, September 6th.—Morning Session 10:00 to 12:00.

Paper: Inductive Interference as a Practical Problem, by A. H. Griswold and R. W. Mastick; Discussion.

Afternoon Session.—2:00 to 5:00.

Paper: Testing for Defective Insulators on High Tension Transmission Lines, by B. G. Flaherty; Paper: High Voltage Potentiometer, by Harris J. Ryan; Paper: Artificial Transmission Line with Adjustable Line Constant, by C. E. Magnusson and S. R. Burbank; Discussion.

Thursday, September 7th.

The program will be supplied for both morning and afternoon sessions by the Pacific Northwest Electric Light & Power Association.

Evening, 8:00.—Lecture by Henry Suzzallo, President University of Washington—The Engineer and the Public; Lecture by W. D'A. Ryan—Illumination of the Panama-Pacific Exposition.

Friday, September 8th.—Morning Session 10:00 to 12:00.

Paper: Characteristics of Admittance Type of Wave Form Standard, by Freedrick Bedell; Paper: Investigation with Transients, by W. D. Peaslee; Discussion.

Afternoon Session.—Automobile trip and boat ride. Evening, Banquet.

In addition to the technical program numerous entertainment features are being provided for the delegates and ladies in attendance.

TRADE NOTES.

The city of Redding, not to be outdone by its neighbor, Red Bluff, intends installing an up-to-date street lighting system and has placed an order for ornamental steel electroliers with the Pacific States Electric Company. These standards will support G. E. Novalux fixtures with compensator for operating either 400 or 600 c.p. series lamps.

The Petroleum Rectifying Company of California has acquired by purchase the United States patents for the Dehydration of Oil formerly owned by the Raney-Laird Petroleum Dehydrating Company. The Traders Oil Company which has been operating a Raney-Laird plant for something over a year has taken a license under the Cottrell patents owned by the Petroleum Rectifying Company, and the infringement suit between these companies will be dropped. The system of removing water from oil by electricity is a purely California conception which has brought about a revolution in the oil industry in this country and abroad. The settlement of the litigation with the Raney-Laird interests will promote further advances in the art due to a combination of the two systems under a strong corporation.

NEW CATALOGUES AND BOOKS.

The Edison Storage Battery Company, Orange, N. J., has just issued a beautiful and interesting treatise on storage batteries in railroad service. "Train Lighting Batteries, Edison," is handsomely illustrated with photographs showing the batteries in actual service, as well as the construction of the individual cell. The text is especially comprehensive and valuable to any railroad man having to do with storage batteries, embracing a thorough description of the manufacture of the cells, their characteristics, battery troubles and their elimination, and giving special attention to the chemical changes involved on charge and discharge. The booklet contains thirty-two pages and is replete with illustrations.

When the large Auditorium at the University of Illinois was built in 1908 it proved to be unsatisfactory in its accoustical properties. Audiences found it difficult to hear speakers owing to marked reverberation and echoes. Dr. F. R. Watson of the Physics Department and James M. White, supervising architect, undertook to correct the fault by conducting a systematic investigation involving a long series of experiments. "Bundles" of sound were projected in different directions and the paths of these were carefully traced. Various instruments, such as a ticking watch, a hissing arch lamp and megaphones were employed and curtains and draperies were hung at critical points suggested by the diagnosis.

Certain of the walls were then covered with hairfelt mounted on thin furring strips with the result that at present a speaker with a moderate voice may be heard distinctly by auditors in the most distant seats of the large building.

The investigations are described in an illustrated booklet issued by the Engineering Experiment Station as Bulletin No. 87. Copies may be had by addressing W. F. M. Goss, Director, Urbana, Illinois.

NEWS NOTES

ILLUMINATION.

SAN RAFAEL, CAL.—The board of supervisors is advertising for bids for installing and caring for 20 lights in Laverne Lighting District of Marin county.

LOS ANGELES, CAL.—Sealed bids will be called for by the board of public service commissioners for furnishing transformers, in accordance with specifications on file.

HAYWARD, CAL.—A new system of electroliers in place of the present overhead lighting will probably be installed following an investigation of the Hayward Chamber of Commerce.

OROVILLE, CAL.—The Pacific Gas & Electric Company has instituted suit in the Superior Court against Henry W. Taylor and Ella C. Taylor to condemn certain land near De Sabla, which they desire to use as a site for a dam in Butte Creek.

GOLDFIELD, NEV.—J. B. Fayant has filed a petition with the board of county commissioners asking for a franchise to construct and maintain, gas mains and all necessary appliances used in connection therewith, in streets and alleys of Goldfield.

LAGUNA BEACH, CAL.—Notice is given that an election will be held here on August 22 for the purpose of determining the question of the formation of a highway lighting district to be known as Laguna Beach Lighting District of Orange county.

LOS ANGELES, CAL.—Plans for the construction of a three-story addition and for alterations to the present building of the California Edison Company on Fourth street, between Main and Los Angeles, are being prepared. The estimated cost is not yet known. The present structure will be transformed into an up-to-date five-story office building.

RIVERSIDE, CAL.—Amended articles of incorporation have been filed by directors of the Banning Gas & Lighting Company. The principal place of business of the company is Banning. Capital stock, $25,000. Directors include C. D. Hamilton, C. S. Holcomb, D. A. Innes, J. M. Westerfield and Dr. J. C. King. D. H. Gates is president and Paul Aylesworth, secretary.

FRESNO, CAL.—The San Joaquin Light and Power Corporation is making rapid progress in the work of laying 40 miles of mains for natural gas in the neighborhood of San Luis Obispo. Natural gas is to be piped from the Santa Maria fields to San Luis Obispo, the Eastern Oil Refinery, Pismo, Haviland, Port San Luis and Oceano for domestic use. The work will be completed within a month.

TRANSMISSION.

KINGMAN, ARIZ.—The Burro Creek Hydroelectric Power Company has secured authority from the Arizona corporation commission to proceed with its enterprise in the Oatman district.

LOS ANGELES, CAL.—A permit has been issued to the city to build a $50,000 electrical substation at 1636 St. John street. The power will enter the city through this main substation with strength of 100,000 volts, and will be distributed through the local station of 30,000 volt lines.

SANTA BARBARA, CAL.—Announcement has been made that the San Joaquin Light & Power Company has purchased the material necessary and is soon to extend its lines to the northern parts of the county. New extensions are planned to reach down into Los Alamos, Los Olivos, Santa Ynez, and Solvang.

WINNEMUCCA, NEV.—Edson F. Adams, president; B. Brown, vice-president and Joseph Bean, general manager of the Nevada Valleys Power Company, are in Winnemucca. It is understood that the company is contemplating extending their electric power line from Rochester to Battle Mountain, passing Winnemucca.

SALEM, ORE.—A permit has been issued to the Idaho Power Company, a $17,000,000 corporation organized under the laws of Maine, to transact business in Oregon, by Corporation Commissioner Schulderman. John A. Laing of Portland is the company's representative in Oregon.

VISTA, CAL.—The transmission lines of the San Diego Consolidated Gas & Electric Company, now being extended from Del Mar to Oceanside, are to be brought inland to Vista and connected with the Oceanside distributing system in the San Luis Rey valley. It is also probable that the lines may be extended to the Twin Oaks, Escondido and San Pasqual valleys. Extensions of lighting and power current are expected to be made in a number of directions with Oceanside as a distributing center.

SAN FRANCISCO, CAL.—The Coast Counties Gas & Electric Company, which distributes electricity and gas in Santa Cruz, Monterey, San Benito and Santa Clara counties and has its principal office in San Francisco, has filed with the Railroad Commission an application for an extension until December 31 of the time in which it may sell first preferred stock heretofore authorized by the commission to be disposed of before June 30. The commission some time ago gave the company permission to sell 1000 shares of this stock at not less than 85 per cent of its par value, and the company reports that it has already sold 852 shares at $90, or $5 a share more than the minimum fixed by the commission. It wishes more time to sell the other shares.

IRRIGATION.

EL CENTRO, CAL.—Officials of the Imperial Irrigation District have received word from the Secretary of War Department permitting the district to construct a temporary rock and pile weir across the Colorado River at Hanlon Heading.

SACRAMENTO, CAL—At a meeting held in Herald, this county, an irrigation district, comprising about 40,000 acres in the southwestern part of the county, was organized. E. R. Walker, representing the Hobart-Hayward-Lane interests, has been promoting the project.

MARYSVILLE, CAL.—Close to 20,000 acres of land in Yuba county will be irrigated by the big irrigation ditch which is being planned in Butte and Yuba counties. The ditch is to leave the Feather River on the Oroville side of Pacific Heights. There will be 16 miles of main ditch to be built in Butte county.

AUBURN, CAL.—The Pacific Gas & Electric Company is actively engaged in the western part of the county signing up farmers and land owners for irrigation. It is stated that the company has sufficient water available to irrigate 35,000 acres in the western part of the county, which is 15,000 acres more than is being irrigated in the Auburn unit.

MODESTO, CAL.—The Waterford irrigation district organized two years ago, has been approved by State Engineer W. F. McClure in his report on the practicability of the district just received. Completion of the project will add 14,000 acres of fertile lands to the irrigated area of Stanislaus. The bond issue will be $465,000, as already figured by the district's engineer and by the state engineer. The necessary petitions calling for the election will be circulated at once.

Journal of Electricity, Power and Gas
ELECTRICAL PRICE INDEX
Number 7

Flexible Steel-Armored Conductors.

		Cost.	List.	Sell.
No. 18.	2-Conductor Cord, per 100	.....	8.00	8.00
No. 14.	2-Conductor Solid, per 100	.....	14.65	14.65
No. 12.	2-Conductor Solid, per 100	.....	16.20	16.20
No. 10.	2-Conductor Solid, per 100	.....	24.95	24.95
No. 14.	3-Conductor Solid, per 100	.....	18.40	18.40
No. 12.	3-Conductor Solid, per 100	.....	25.50	25.50
No. 10.	3-Conductor Solid, per 100	.....	35.45	35.45

Conduit Fittings.

Bushings Porcelain Lined.

½ in.	.....	.25	.25
¾ in.	.....	.35	.35
1 in.	.....	.50	.50
1¼ in.	.....	.65	.65
1½ in.	.....	.90	.90
2 in.	.....	1.20	1.20
2½ in.	.....	1.65	1.65
3 in.	.....	4.00	4.00

Non-Metallic Flexible Conduit.
Full Coils 25% Off.

		Per 100	Per 100
2/8 in.	.....	$ 5.50	$ 5.00
5/16 in.	.....	6.00	5.40
⅜ in.	.....	9.00	8.10
½ in.	.....	12.00	10.80
Ordinary Fastener	.....	2.00	2.00
Universal Fastener	.....	3.00	3.00

Couplings—Each.

½ in.	.....	.07	.07
¾ in.	.....	.10	.10
1 in.	.....	.13	.13
1¼ in.	.....	.17	.17
1½ in.	.....	.21	.21
2 in.	.....	.28	.28
2½ in.	.....	.40	.40
3 in.	.....	.60	.60
3½ in.	.....	.80	.80
4 in.	.....	1.00	1.00

The correctness of these suggested selling prices is not guaranteed by the publisher.

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Journal of Electricity, Power and Gas
ELECTRICAL PRICE INDEX
Number 8

Elbows—Each.

	Cost.	List.	Sell.
½ in.	.....	.19	.19
¾ in.	.....	.25	.25
1 in.	.....	.37	.37
1¼ in.	.....	.45	.45
1½ in.	.....	.60	.60
2 in.	.....	1.10	1.10
2½ in.	.....	1.80	1.80
3 in.	.....	4.80	4.80
3½ in.	.....	10.60	10.60
4 in.	.....	12.25	12.25

Conduit Bushings—Per 100.

½ in.	.....	$ 6.00	$ 4.50
¾ in.	.....	8.00	6.00
1 in.	.....	15.00	11.25
1¼ in.	.....	18.00	13.50
1½ in.	.....	20.00	15.00
2 in.	.....	40.00	30.00
2½ in.	.....	60.00	45.00
3 in.	.....	90.00	67.50
3½ in.	.....	150.00	112.50
4 in.	.....	200.00	150.00
4½ in.	.....	400.00	300.00

Steel Conduit Locknuts—Per 100.

½ in.	.....	1.50	1.15
¾ in.	.....	2.50	1.90
1 in.	.....	5.00	3.75
1¼ in.	.....	8.00	6.00
1½ in.	.....	12.00	9.00
2 in.	.....	20.00	15.00
2½ in.	.....	30.00	22.50
3 in.	.....	40.00	30.00
3½ in.	.....	60.00	45.00
4 in.	.....	100.00	75.00

No Thread Nipples—Each.

½ x ½	.....	.20	.20
½ x ¾	.....	.25	.25
¾ x ¾	.....	.25	.25

No Thread Couplings.

½	.....	.40	.40
¾	.....	.50	.50

The correctness of these suggested selling prices is not guaranteed by the publisher.

ALPHABETICAL INDEX TO ADVERTISERS

The letter and number before each name are used in the classified page following

A-1 American Ever-Ready Works of National Carbon Co..
Los Angeles; 755 Folsom St., San Francisco; Seattle.

A-2 Atchison, Topeka & Santa Fe Railway Co.....
673 Market St., San Francisco; 1218 Broadway, Oakland.

B-1 Baker-Joslyn Company..... 2
71 New Montgomery St., San Francisco; 911 Western Ave., Seattle; 353 E. Second St., Los Angeles.

B-2 Benjamin Electric Manufacturing Co.....
590 Howard St., San Francisco.

C-1 Century Electric Co..... 2
906 So. Hope St., Los Angeles; 56 Natoma St., San Francisco; 65 Front St., Portland, Ore.

C-3 Crocker-Wheeler Co.....
87 New Montgomery St., San Francisco; 228 Central Avenue, Los Angeles.

C-4 Cutler-Hammer Manufacturing Co.....
579 Howard St., San Francisco; Morgan Bldg., Portland, Ore.; San Fernando Bldg., Los Angeles.

D-4 Davis Slate & Manufacturing Co.....
Chicago, Ill.

D-2 Dearborn Drug and Chemical Works..... 4
355 East Second St., Los Angeles; 301 Front St., San Francisco.

E-7 Economy Fuse & Mfg. Co.....
Kinzie and Orleans Sts., Chicago.

E-1 Edison Lamp Works of General Electric Co.....
Rialto Bldg., San Francisco; 724 So. Spring St., Los Angeles.

E-2 Edison Storage Battery Supply Co..... 4
441 Golden Gate Ave., San Francisco.

E-3 Electric Agencies Co.....
247 Minna Street, San Francisco; Central Building, Los Angeles.

E-6 Electric Novelty Works.....
533 Mission St., San Francisco.

E-4 Electric Storage Battery Co.....
743 Rialto Bldg., San Francisco.

E-5 Electric, Railway & Manufacturing Supply Co..... 4
34 Second St., San Francisco.

F-1 Fairbanks, Morse & Co.....
Los Angeles; Portland; 651 Mission St., San Francisco; Seattle; Spokane.

F-3 Federal Sign System (Electric).....
618 Mission St., San Francisco.

G-1 General Electric Co..... 3-10-11
724 So. Spring St., Los Angeles; Worcester Bldg., Portland; Rialto Bldg., San Francisco; Colman Bldg., Seattle; Paulsen Bldg., Spokane.

G-1 General Vehicle Co.....
1117 Van Ness Ave., San Francisco; 331 Wall St., Los Angeles; British Columbia Electric Ry., Ltd., Vancouver, B. C.

H-1 Habirshaw Electric Cable Co., Inc.....
(See Western Electric Company.)

H-2 Hemingray Glass Co..... 3
236-240 So. Los Angeles St., Los Angeles; 345 Oak St., Portland; 807 Mission St., San Francisco.

H-3 Haller-Cunningham Electric Co.....
428 Market St., San Francisco.

H-5 Hunt, Mirk & Co.....
141 Second St., San Francisco.

H-7 Hurley Machine Co.....
New York and Chicago. (See Pacific States Electric Co.

I-2 Illinois Electric Co.....
261-263 So. Los Angeles St., Los Angeles.

I-3 Interstate Electric Novelty Co.....
111 New Montgomery St., San Francisco.

L-1 Leahy Manufacturing Co.....
Eighth and Alameda St., Los Angeles.

L-2 Locke Insulator Manufacturing Co..... 5
(See Pierson, Roeding & Co.)

M-2 McGlauflin Manufacturing Co.....
Sunnyvale, Cal.

M-4 Morse Chain Company.....
Monadnock Bldg., San Francisco.

M-3 Moore & Co., Charles C..... 3
Van Nuys Bldg., Los Angeles; Spalding Bldg., Portland, Kearns Bldg., Salt Lake City; Sheldon Bldg., San Francisco; Mutual Life Bldg., Seattle; Santa Rita Hotel Bldg., Tucson.

N-1 Nason & Co., R. N.....
151 Potrero Ave., San Francisco.

N-6 National Carbon Company..... 5
Cleveland, Ohio.

N-2 National Conduit & Cable Co., The.....
Trust and Savings Bldg., Los Angeles; Rialto Bldg., San Francisco.

N-3 National Lamp Works of G. E. Co.....
(All Jobbers.)

N-4 New York Insulated Wire Co.....
629 Howard St., San Francisco.

N-5 Northwestern Pacific Railroad.....
808 Phelan Bldg., San Francisco.

O-1 Okonite Co. (The)..... 12
(All Jobbers.)

P-1 Pacific Electric Manufacturing Co.....
80 Tehama St., San Francisco.

P-2 Pacific States Electric Co..... 2
236-240 So. Los Angeles St., Los Angeles; 61-67 Fifth St. No., Portland; 200-210 Twelfth St., Oakland; 575 Mission St., San Francisco; 307 First Ave. So., Seattle.

P-4 Pelton Water Wheel Co..... 3
2219 Harrison St., San Francisco.

P-5 Pierson, Roeding & Co.....
Pacific Electric Bldg., Los Angeles; Rialto Bldg., San Francisco; Colman Bldg., Seattle.

P-6 Pittsburgh Electric Specialties Company.....
202 Aronson Bldg., San Francisco.

P-7 Pittsburgh Piping & Equipment Co..... 12
Monadnock Bldg., San Francisco.

S-1 Schaw-Batcher Company, Pipe Works, The.....
211 J St., Sacramento; 356 Market St., San Francisco.

S-4 Southern Pacific Co..... 4
Flood Bldg., San Francisco.

S-5 Sprague Electric Works..... 12
Rialto Bldg., San Francisco; Colman Bldg., Seattle; Corporation Bldg., Los Angeles; Electric Bldg., Portland; Paulsen Bldg., Spokane.

S-6 Standard Underground Cable Co..... 4
First National Bank Bldg., San Francisco; Hibernian Bldg., Los Angeles; Central Bldg., Seattle, Wash.; 815 Newhouse Bldg., Salt Lake City, Utah.

T-1 Thomas & Co., R..... 12
Pacific States Electric Co. and Western Electric Co., Pacific Coast Representatives.

T-2 Tubular Woven Fabric Company.....
Pawtucket, R I.

U-1 United Sheet Metal Works.....
575 Howard St., San Francisco.

W-1 Wagner Electric Manufacturing Company..... 12
St. Louis, Mo.

W-2 Western Electric Co.....
Eighth and Santee Sts., Los Angeles; 1900 Telegraph Ave., Oakland, Cal.; 680 Folsom St., San Francisco; 907 First Ave., Seattle; 45 North Fifth St., Portland, Ore.

W-3 Ward-Leonard Electric Co..... 5
Mt. Vernon, New York.

W-4 Westinghouse Electric and Manufacturing Co..... 6
50-52 East Broadway, Butte; Van Nuys Bldg., Los Angeles; Couch Bldg., Portland; 212 So. W. Temple, Salt Lake City; 165 Second St., San Francisco; Second and Cherry Sts., Seattle; Paulsen Bldg., Spokane.

W-5 Westinghouse Machine Co.....
141 Second St., San Francisco.

W-6 Westinghouse Lamp Co.....
(See Westinghouse Electric & Manufacturing Co.)

W-8 Western Pipe & Steel Co.....
444 Market St., San Francisco; 1758 North Broadway, Los Angeles.